

NERL Research Abstract

EPA's National Exposure Research Laboratory

GPRA Goal 8 - Sound Science

APM # 632

Significant Research Findings

Relationships between Macroinvertebrates, Periphyton Assemblages, and Chemical and Physical Stressors in the Mid-Atlantic Streams

Purpose

Wildlife living in streams are both a valued resource and an indicator of stream quality. The relationships between chemical and physical stressors and how they affect wildlife living in streams were developed to serve several functions. The information was used to develop general indicators of stream condition based on the invertebrates and algae living on the stream bottom. These are important measures that are used to determine if streams meet designated uses as required by the Clean Water Act. The information was also used to determine intensities of stressors that result in damage to stream ecosystems. These relationships can be used along with other lines of evidence to identify the likely causes of ecological impairment for listing under section 303(d) of the Clean Water Act, a required step in the calculation of total maximum daily loads (TMDLs).

Research Approach

Periphyton were collected from 233 stream site-visits (49 in 1993, 56 in 1994, and 128 in 1995) throughout the Mid-Appalachian region. Periphyton index were identified to species and analyzed by metrics, including 1) algal genera richness, 2) the relative abundances of diatoms, Cyano-bacteria, dominant diatom genus, acidophilic diatoms, eutraphentic diatoms, and motile diatoms, 3) chlorophyll and biomass (ash-free dry mass) standing crops, and 4) alkaline phosphatase activity. Thirty-seven diatom genera and 38 non-diatom genera were collected. The relative richness and relative abundance (RA) of these genera were regressed against chemical and physical attributes of the collecting locations.

Macroinvertebrate samples were collected from 407 stream site-visits throughout the Mid-Appalachian region during 1993-1995. These samples were identified to species and used to develop a stream benthos integrity index (SBII) based on metrics that represented population, community, and pollution tolerance measures. As part of the development process, forty

macroinvertebrate metrics were evaluated for responses to physical habitat and chemical indicators of catchment stream disturbance.

Major Findings and Significance

Ten periphyton metrics were correlated with 27 chemical, 12 physical habitat, and 3 landscape variables. Component metrics were significantly correlated with several chemical, physical habitat, and landscape variables. Canonical correlation analysis revealed significant correlations between the 10 metrics and 4 significant environmental gradients related to general human disturbances (stream acidity, stream substrate composition, and stream and riparian habitat).

Thirty-five potential stressors, including variables for water chemistry, RBP habitat, and watershed characteristics were used in the evaluation of macroinvertebrate metrics. Over half of the forty metrics evaluated were correlated with one or more stressor variables. Numbers and percentages of Plecoptera taxa, EPT taxa, and intolerant taxa, HBI, and percentages of tolerant taxa, chironomid taxa and Ephemeroptera individuals were all significantly correlated with several chemistry variables. Number and percentage of Plecoptera taxa, percentages of intolerant taxa, tolerant taxa, EPT taxa, and chironomid taxa, and the HBI were all also significantly correlated with most of the physical habitat measures and watershed characteristics. Only percent predator individuals and percent Megaloptera taxa showed no significant correlations with any of the watershed, habitat, or chemistry variables.

Research Collaboration and Publications

Preparation of this manuscript was a joint effort of the National Exposure Research Laboratory in Cincinnati, OH, and the National Health and Environmental Effects Laboratory in Corvallis, OR, the Department of Biology, University of Louisville, EPA Region III, and states in Regions II, III and IV.

- Hill, B.H., Herlihy, A.T., Kaufmann, P.R., Stevenson, R.J., McCormick, F.H., Johnson, C.B. Technical Support Document for the Use of Periphyton Assemblage Data in an Index of Biotic Integrity. U.S. Environmental Protection Agency, Cincinnati, OH. 2000.
- Pan, Y., Stevenson, R.J., Hill, B.H., Herlihy, A.T., Collins, G.B. Using diatoms as indicators of ecological conditions in lotic systems: a regional assessment. *Journal of the North American Benthological Society* 15: 481-495, 1996.
- Pan, Y., Stevenson, R.J., Hill, B.H., Kaufmann, P.R., Herlihy, A.T. Spatial patterns and ecological determinants of benthic algal assemblages in Mid-Atlantic streams, USA. *Journal of Phycology* 35: 460-468, 1999.
- Klemm, D.J., Blocksom, K., Thoeny, W.T., Fulk, F.A., Herlihy, A.T., Kaufmann, P.R., Cormier, S.M. A Macroinvertebrate Stream Benthos Integrity Index (SBII) for Bioassessment of Streams in the Mid-Atlantic Highlands Region. Technical support document. 2000.
- Klemm, D.J., Blocksom, K., Thoeny, W.T., Fulk, F.A., Herlihy, A.T., Kaufmann, P.R., Cormier, S.M. Macroinvertebrate Stream Benthos Integrity Index (SBII) for bioassessment of streams in the mid-Atlantic highlands region. *Journal of the North American Benthological Society*. Submitted.

The survey design, technical reports, and journal articles were reviewed and approved in accordance with Office of Research and Development's scientific peer review procedures.

**Future
Research**

Similar research will be performed using data collected from deep rivers. Future work will also develop a method to classify Wadeable Streams so that managers can separately evaluate natural and man-made influences on biota.

Questions and inquiries concerning the relationships between stressors and biological measurements should be directed to Dr. Donald Klemm for benthic macroinvertebrates, Dr. Brian Hill for periphyton, and Florence Fulk for statistical analyses.

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